[11839/12]

ROTARY SLIDE VALVE FOR POWER-ASSISTED STEERING SYSTEMS OF MOTOR VEHICLES

The invention relates to a rotary slide valve for power-assisted steering systems of motor vehicles of the type defined in more detail in the preamble of claim 1.

Rotary slide valves for power-assisted steering systems normally contain two valve elements which are arranged so as to be movable coaxially one in the other and are arranged so as to be rotatable relative to one another to a limited extent in order to achieve a control travel. In this case, the first valve element, which is connected to a valve input member, is designed as a radially outer rotary slide. A second valve element is connected fixedly in terms of rotation to a valve output member designed as a driving pinion and is designed as a radially inner control bush. The rotary slide is additionally connected to the driving pinion via a backlash coupling limiting a control travel. Both valve elements have longitudinal control grooves which are limited at least partially in their axial extent and serve for controlling a pressure medium from or to working spaces of a servomotor.

A torsion-bar spring serves for resetting the two valve elements from a deflected position into their neutral position.

In the known rotary slide valves, the control bush is suspended in a suspension pin pressed into the driving pinion. For this assembly step, it is necessary to have play in the suspension connection between the suspension pin and the control bush. However, because of the play which is present,

a relative movement may occur between the rotary slide and the control bush, without a steering torque having been introduced by a steering handwheel. This results in undesirable oil streams to the working spaces of the servomotor. These undesirable oil streams are manifested, in addition, by steering torque jumps on the steering handwheel, which result in selfsteering effects and may therefore lead to the driver having a feeling of uncertainty.

In the exemplary embodiments described hitherto, the rotary slide is connected fixedly to the valve input member and the control bush to the valve output member. There are, however, also rotary slide valves which operate with valve elements assigned in reverse. The invention may likewise be used, along with the same benefits, for these rotary slide valves.

The valve output member may be designed as a driving pinion or as a ball screw, depending on use in rack-and-pinion or ball-and-nut power-assisted steering systems.

Such a rotary slide valve is described in DE 41 08 597 A1.

The rotary slide valve is designed in such a way that the engagement dimensions of the take-up connection are sufficiently large to ensure a firm fit, without this resulting in a large-size valve assembly. The take-up pin, which projects at right angles from an outer circumference of the pinion shaft, is inserted into a pin hole which extends in the radial direction of the valve bush. The pinion shaft is thereby operatively connected to the valve bush. The mid-axis of the inside diameter of the valve bush intersects the mid-axis of the pin hole and is displaced from the mid-axis of the

valve assembly in the direction of that side of the valve assembly which is located opposite the pinhole.

The object on which the present invention is based is to present a rotary slide valve, in which the play between the valve input member and the valve output member is eliminated and angular and longitudinal movability is nevertheless maintained between a valve element designed as a control bush and a valve output member designed as a driving pinion, in order to allow the compensation of lateral error.

The object on which the invention is based is achieved by means of a generic rotary slide valve also having the defining features of the main claim.

The connection of the control bush to the driving pinion is made by means of a tolerance-insensitive and play-free press connection in the form of a connecting element. The connecting element may be connected in one piece to the control bush or else be coupled to the control bush by forming or joining.

The control bush or the connecting element may be designed in the connection region as a solid shaft, a hollow shaft or a polygon.

The connecting element may have a profile, for example in the form of a boss located on the circumference, which profile may be applied both to the control bush and in the driving pinion. It is necessary merely to ensure a tolerance-insensitive, centric and play-free connection of the two parts.

By virtue of a flexible configuration of a region between a connection region of the control bush and the driving pinion and a control region of the control bush, transverse forces acting from outside can be distributed uniformly and the two parts can therefore be fixed, free of play, relative to one another. Lateral and angular errors which are present can thereby be compensated in such a way that there are no distortions within the rotary slide valve.

The flexibility of the region between a connection region of the control bush and the driving pinion and a control region of the control bush is obtained by the introduction of at least one cut and is influenced by the width, depth and length of the latter and by the arrangement and density of the cuts.

The cuts are introduced by high-energy beam cutting, plasma cutting, erosion cutting, punching, grinding or milling.

Forces acting from outside, such as distortions in the steering column, elastic influences or different thermal expansions of the individual components in relation to one another, which adversely influence the functioning of previous rotary slide valves, are avoided. Production tolerances can also be compensated in terms of their influences on the functioning of the rotary slide valves.

Assembly is carried out merely by joining together axially; this affords advantages with regard to the outlay in terms of production and assembly.

Assembly may also be carried out fully automatically with the aid of force/path monitoring, thus leading to a higher reproducibility of quality and functioning.

Advantageous and expedient refinements of the invention are specified in the subclaims. However, the invention is not restricted to the feature combinations of the claims, but, instead, the set object affords a person skilled in the art with further expedient combination possibilities of claims and individual claim features.

An exemplary embodiment of the present invention is described below, in principle, with reference to the figures of which:

Figure 1 shows a longitudinal section through a rotary slide valve according to the invention by the example of a rack-and-pinion power-assisted steering system of motor vehicles;

Figure 2 shows a detail of a rotary slide valve according to the invention on an enlarged scale, and

Figure 3 shows a section along the line III-III of the detail of a rotary slide valve according to the invention which is illustrated in figure 2.

The invention is described with reference to the example of a rotary slide valve for a rack-and-pinion power-assisted steering systems. The invention may, however, also be applied, to the same effect, to other power-assisted steering systems, for example ball-and-nut power-assisted steering systems.

A rotary slide valve 1 according to the invention contains a first valve element in the form of a rotary slide 2 and a second valve element which is designed as a control bush 3.

The rotary slide 2 is connected fixedly in terms of rotation to a valve input member 4 which may be designed as a steering spindle connection. The steering spindle connection is connected, for example, to a steering spindle, not illustrated, which carries a steering handwheel, via a cardan joint which is likewise not illustrated. Moreover, the rotary slide 2 is connected to a valve output member 5 via a backlash coupling, not illustrated.

The valve output member 5 may be designed as a driving pinion or as a ball screw, depending on use in rack-and-pinion or ball-and-nut power-assisted steering systems.

Arranged on the outer cylindrical surface of the rotary slide 2 are longitudinal control grooves 6 which cooperate with longitudinal control grooves 7 of the control bush 3.

Depending on the direction of rotation, the rotary slide valve 1 makes a pressure-medium connection with a servomotor, not illustrated, via the longitudinal control grooves 6 and 7 and via annular grooves 8 in the control bush 3.

Furthermore, the valve input member 4 is connected to the valve output member 5 via a torsion-bar spring 9. The valve output member 5, in turn, is connected fixedly in terms of rotation to the control bush 3 via a connecting element 10. These various connections with one another make it possible to have a limited relative rotation of the rotary slide 2 in relation to the control bush 3. As a result of this relative rotation of the valve elements in relation to one another, the pressure medium conveyed by a power-steering pump, not illustrated, is conducted, via a pressure-medium reservoir, likewise not illustrated, from the relieved working space of

the servomotor, not illustrated, into the loaded working space of the latter.

The coupling of the valve output member 5 and the control bush 3 is carried out by means of a connecting element 10 which is connected in one piece to the control bush 3 here. The connecting element 10 is pressed into the valve output member 5 and is secured against rotation by means of a boss contour 11. This allows a play-free take-up. The connecting element 10 is connected to the valve output member 5 in a connection region 12. The connection region 12 is spatially separated from a control region 13 of the control bush 3 by means of a region 14. In this region 14, at least one cut 15 is made, which ensures torsional rigidity and flexibility of this region 14.

Reference symbols

1. Rotary slide valve
2. Rotary slide
3. Control bush
4. Valve input member
5. Valve output member
6. Longitudinal control grooves (rotary slide)
7. Longitudinal control grooves (control bush)
8. Annular grooves
9. Torsion-bar spring
10. Connecting element
11. Boss contour
12. Connection region
13. Control region
14. Region
15. Cut